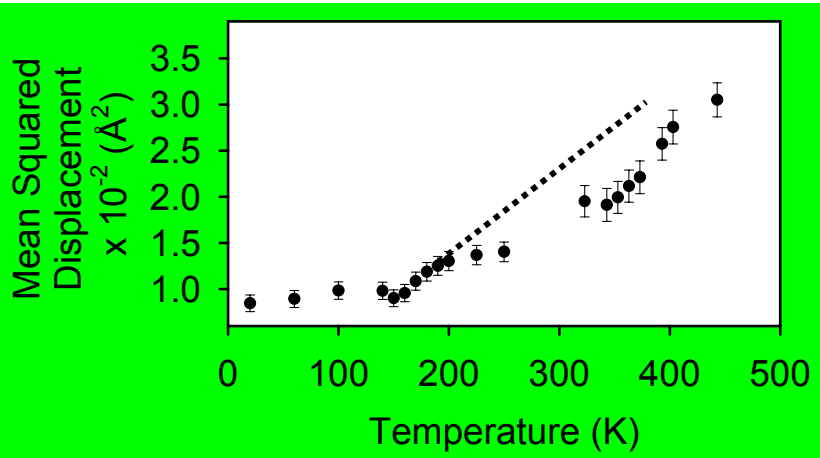
X-ray Absorption Spectroscopy of Thermal Behavior in Polymers

Brian Grady, University of Oklahoma, DMR-9733068

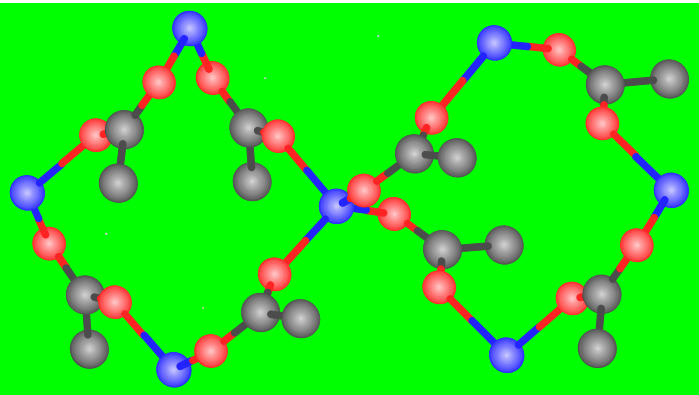
Intellectual Merit

• The glass transition is a very important property of all polymers, and, as one example, was the fundamental cause of the Space Shuttle Challenger disaster. Our studies of the fundamentals of this transition has led to evidence suggesting that non-equilibrium structures on the angstrom length scale can be frozen in as a polymer solidifies into a glass, which is a much smaller length scale than one normally thinks of when characterizing the glass transition.

•Carboxylate ionomers are polymers having a small mole fraction of metal cations ionically attached via carboxylates to the polymer backbone, and are used widely in food packaging applications, sporting goods, automotive uses etc. (approximately 300 million pounds per year produced). Two primary commercial forms exist, sodium and zinc, and our work has shown that many of the macroscopic property differences between these two types, i.e. water absorption, hardness, adhesive ability, are due to differences in the unique nanometer-scale phase structure of these two materials.



Anomalous behavior at glass transition. Dashed line represents "normal" behavior



Crystal-like structure of nanometer size aggregates containing zinc atoms (blue) in carboxylate ionomers. Sodium ionomers do not have a crystal-like structure

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Broader Impacts

- Grant, which recently ended, supported four graduate students and seven undergraduate students, with one of the former and four of the latter from historically underrepresented minorities. Three of the four graduate students have graduated and one more will graduate soon.
- 11 journal publications, including one invited book chapter.
- Currently have two research contracts with Halliburton Inc.
- Speak to many high-school students and college freshmen about science careers.
- Awarded "Advisor of the Year", Interfraternity Council, University of Oklahoma, 1999; Continue as Faculty Advisor to Triangle Fraternity.
- Mentor for ~8 freshmen students/year at OU.
- Newsletter Editor for the industry-dominated Oklahoma City Section of the Society of Plastics Engineers (http://coecs.ou.edu/Brian.P.Grady/spelocal/)